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Constructive and Reconstructive Processes in Memory

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Introduction/overview

Have you ever gotten together with friends to reminisce about old times and found that not everyone remembers things the way you do? Was Harry really there? Was George with Harry? Who arrived first? Why didn't Mary go too? Sometimes when listening to someone describe an event that we also witnessed, we begin to wonder whether we experienced the same event. Errors or lapses in memory can be the source of mild disputes in social situations. In other situations an inability to remember the exact sequence of events or to identify who was present can have serious consequences, as when an eyewitness fails to remember that a particular person was present at the scene of a crime.

In this chapter we will examine some of the reasons recall of complex events may often be inaccurate and differ drastically from one person to another. The impetus for research in this area is the work of the English psychologist, Frederick C. Bartlett, who investigated the types of changes people introduce when attempting to reproduce lengthy verbal passages. Bartlett identified both constructive and reconstructive processes in memory. Construction is associated with the processes of inference or integration, which frequently accompany our attempts to comprehend meaningful material. Suppose you're told the following: Johnny tripped over the chair and went into the pool. A reasonable inference is that the act of tripping caused Johnny to fall into the pool. But you need not construct the meaning of the sentence that way. The sentence could be describing Johnny's progress toward the pool, his tripping, in other words, occurring before he got to the pool. How you interpret the sentence will affect the way you remember it.

How you remember information may also be affected by how you reconstruct it. Reconstruction is the process of inferring the past, rather than merely reproducing it on the basis of what was originally stored in memory. Reconstruction is assumed to be based on our general knowledge of the circumstances surrounding the original event, any general impressions or reactions we might have formed, and any details of the event we still remember when retention is tested. Assume again we are told that Johnny tripped over a chair and went into the pool. With the passage of time we can expect to forget details of the original information. We might later remember that Johnny tripped near a pool. He had to trip over something; so we might reasonably infer that it was a table because we know that tables can be found next to pools. Our reconstruction of the original sentence will involve Johnny tripping over a table. One of the hypotheses to be examined in this chapter is that reconstruction is affected by information we add after we experience an event. Suppose we learned afterwards that Johnny drowned while he was in the pool. Under these conditions would our memory for the original event be "changed" to accommodate this new information? Would we, for instance, be likely to remember that Johnny died because he tripped over a chair (or table), fell into the pool, and drowned? Research we review in this chapter suggests this might be the case.

*The idea that memory is constructive as well as reconstructive has led psychologists to examine the structure and organization of knowledge and to identify possible ways knowledge might interact with information presented for a memory test. We will look briefly at some of the descriptions of the way knowledge is represented and illustrate how differences in prior knowledge can lead to differences in retention.**

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*What we generally think of as "knowledge"—that is, our memory for abstract concepts, well-learned facts (who was the first president of the U.S.?), particular topics (geography, mathematics, football, sewing), meanings of words, and so forth—is sometimes referred to as *semantic* or *generic memory* (see Hintzman, 1978). This type of memory is generally devoid of spatial-temporal information. For instance, it is unlikely that you can remember exactly where or when you learned the name of the first

In the light of research findings regarding reconstructive processes in memory, we will examine the apparently widely held assumption that memory is permanent. Do we really retain all we experience in its original form or is memory malleable and capable of change as new information is accommodated? We begin with a review of Bartlett's important findings and a discussion of the hypotheses he offered to explain the distortions in our recall of everyday events.

BARTLETT'S EXPERIMENTS

Bartlett was originally interested in perception, but this led him to consider related factors—namely, the mental processes associated with imagery and recall. To investigate these processes, he set out on the course originally charted by Ebbinghaus (1885/1964) but soon found it less than satisfactory.

> Long before this, Ebbinghaus had introduced the "exact methods" of nonsense syllables into the Laboratory consideration of memory. As in duty bound, I followed his lead and worked for some time with nonsense material. The result was disappointment and a growing dissatisfaction. . . . The upshot was that I determined to try to retain the advantages of an experimental method of approach, with its relatively controlled situations, and also to keep my study as realistic as possible. I therefore built up, or selected, material which I hoped would prove interesting in itself, and would be of the type which every normal individual deals with constantly in his daily activities [Bartlett, 1932, p. v].*

Bartlett selected the very material that Ebbinghaus had rejected. Prose material, Ebbinghaus (1885/1964) had complained, was sometimes descriptive, sometimes reflective; it included various metaphors; it was occasionally humorous or pathetic; and the rhythm was never the same. This kind of material, he concluded, introduced a "multiplicity of influences which change without regularity and are therefore disturbing" (Ebbinghaus, 1885/1964, p. 23). Ebbinghaus felt that this could be avoided by using nonsense syllables. But prose

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president of the U.S. or that 2 plus 2 is 4. These things are simply known. Following a distinction made by Tulving (1972), we can contrast semantic memory with *episodic memory*. This second type of memory refers to our memory for episodes in our lives (sometimes called remembrances). Episodic memory generally contains spatial-temporal information and is autobiographical—that is, it is an experiential record of our past. Your memory for what you ate for breakfast today or the last word in a list of words recently presented to you are instances of episodic memory. Although we have chosen not to emphasize the distinction between semantic and episodic memory in this book, it is an important one and we want you to be aware of it.

*From *Remembering: A Study in Experimental and Social Psychology*, by F. C. Bartlett. Copyright 1932 by Cambridge University Press. This and all other quotations from this source are reprinted by permission.

material is the stuff of everyday experiences and Bartlett set out to discover what people remember of such ordinary information.

Bartlett's experiments were simply performed. One method he used was called *serial reproduction.* This is similar to a party game known as "Telephone" or "Gossip" (depending on which part of the country you are from). One person tells a story or describes an event to another person. The second person relates the material to a third person, who relates the material to another person, and so forth. What the last person in the chain remembers is compared to the original version. Although we may identify this method with a children's game, it is nevertheless the way people have passed stories, jokes, and even gossip from one person or social group to another for thousands of years. A second method Bartlett relied on was *repeated reproduction.* He asked a person to read a passage or examine a picture and then on more than one occasion attempt to reproduce the original event. Bartlett usually asked for the first reproduction about 15 minutes after the material was presented. Later reproductions were requested at various intervals, after days, weeks, or even years. Bartlett intended both these methods to reveal the nature of recall and in particular the kinds of transformations people make when attempting to remember prose or picture material.

One of the verbal passages Bartlett used was a North American folk tale. The original version is as follows:

The War of the Ghosts

> One night two young men from Egulac went down to the river to hunt seals, and while they were there it became foggy and calm. Then they heard war-cries, and they thought: "Maybe this is a war-party." They escaped to the shore, and hid behind a log. Now canoes came up, and they heard the noise of paddles, and saw one canoe coming up to them. There were five men in the canoe, and they said:
>
> "What do you think? We wish to take you along. We are going up the river to make war on the people." One of the young men said: "I have no arrows." "Arrows are in the canoe," they said. "I will not go along. I might be killed. My relatives do not know where I have gone. But you," he said, turning to the other, "may go with them." So one of the young men went, but the other returned home.
>
> And the warriors went on up the river to a town on the other side of Kalama. The people came down to the water, and they began to fight, and many were killed. But presently the young man heard one of the warriors say: "Quick, let us go home: that Indian has been hit." Now he thought: "Oh, they are ghosts." He did not feel sick, but they said he had been shot.
>
> So the canoes went back to Egulac, and the young man went ashore to his house, and made a fire. And he told everybody and said: "Behold I accom-

> panied the ghosts, and we went to fight. Many of our fellows were killed, and many of those who attacked us were killed. They said I was hit, and I did not feel sick."
>
> He told it all, and then he became quiet. When the sun rose he fell down. Something black came out of his mouth. His face became contorted. The people jumped up and cried. He was dead [Bartlett, 1932, p. 65].

Bartlett had chosen a story containing elements foreign to the English culture from which he drew his subjects. He felt this material would be particularly likely to undergo transformation in his subjects' successive reproductions. It is also apparent from reading the story that parts of it do not seem connected to other parts. This, too, Bartlett (1932, p. 64) suggested, would provide an opportunity to observe changes as the subjects dealt with what he called a "lack of obvious rational order" in the story.

Typical of the recall Bartlett observed when the method of repeated reproductions was used is the following reproduction given by a subject several months after reading the original story. This was the subject's fourth recall attempt since reading the story.

> *The War of the Ghosts*
>
> Two youths went down to the river to hunt for seals. They were hiding behind a rock when a boat with some warriors in it came up to them. The warriors, however, said they were friends, and invited them to help them to fight an enemy over the river. The elder one said he could not go because his relations would be so anxious if he did not return home. So the younger one went with the warriors in the boat.
>
> In the evening he returned and told his friends that he had been fighting in a great battle, and that many were slain on both sides. After lighting a fire he retired to sleep. In the morning, when the sun rose, he fell ill, and his neighbours came to see him. He had told them that he had been wounded in the battle but had felt no pain then. But soon he became worse. He writhed and shrieked and fell to the ground dead. Something black came out of his mouth. The neighbours said he must have been at war with the ghosts [Bartlett, 1932, p. 74].

Bartlett observed that several things were apparent and consistent in his subjects' reproductions. Perhaps the most obvious was that recall was rarely accurate in a literal sense. Subjects elaborated, omitted details, and even introduced new elements to the story. Further, repeated reproductions by the same subject revealed that a persistent outline or form emerged in the recall attempts. The story, in other words, became "stereotyped." Some of these changes Bartlett thought to be due to the use of visual imagery. Others he attributed to a subject's familiarity with a particular element, to personal preferences or interests, or to a process referred to as *rationalization.* This was defined as an attempt by the subject to make the material more readily understandable, comfortable, and "satisfying." For example, you may have noted that in the subject's reproduction just cited the word *boat* is substituted for *canoe.* Bartlett argued that his English subjects were more comfortable with the term *boat* than *canoe.*

Bartlett (1932, p. 213) summarized his findings as follows:

> Remembering is not the re-excitation of innumerable fixed, lifeless and fragmentary traces. It is an imaginative reconstruction, or construction, built out of the relation of our attitude towards a whole active mass of organised past reactions or experience, and to a little outstanding detail which commonly appears in image or in language form.

We therefore find in Bartlett's experiments the basis for both a constructive and reconstructive hypothesis regarding changes in retention. The processing of prose material is seen as an active interaction between the learner's knowledge and the to-be-remembered text. This interaction is often constructive, leading to inferences or producing elaboration of the to-be-remembered material. Bartlett also considered memory to be largely reconstructive. He assumed that, as time passes, we rely more and more on our general knowledge and impressions of an event and less on memory for the original details. Therefore we would have to infer and reconstruct certain aspects of the original event on the basis of our general knowledge and impressions of the event. Memory was not, in other words, a literal reproduction of the past. In the following sections we will look more closely at these major hypotheses about retention of prose material. Before that, however, we will examine an important concept Bartlett introduced, that of *schemata,* and briefly mention its relation to more contemporary concepts.

SCHEMATA, SCRIPTS, AND FRAMES

Despite the significance of Bartlett's observations and his hypotheses about prose recall, for many years his contributions were generally unrecognized, particularly by American psychologists. His informal treatment of data and his interpretations in terms of visual imagery, attitude, and constructive and reconstructive processes did not find a ready acceptance in a psychology given to statistical treatment of verbal responses and explanations in terms of stimulus-response associations. Perhaps most unsettling to a psychology that had only recently abandoned introspection and the use of mentalistic concepts was Bartlett's notion of *schemata* (singular: schema). According to Bartlett (1932), schemata represent the mass of active organizations of past reactions or experiences. Any one schema presumably is the organized knowledge of a particular set of material or specific type of past experience. Bartlett assumed the changes he found in his subjects' reproductions of prose material reflected a dependence on schemata related to the story or into which the story mapped. As the retention interval increased, the subject relied more and more on these general schemata when attempting recall. Schemata, in other words, were the basis for reconstruction in memory. Consequently, there was a loss of detail in the subject's reproductions, some degree of elaboration, and an overall tendency to make the story comfortable or satisfying.

With the renewal of interest in memory for prose material that began in the late 1960s in American psychology, schemata were once again invoked as an explanatory device. According to Thorndyke and Hayes-Roth (1979, p. 82), "A memory schema, as it is typically conceptualized today, is a cluster of knowledge (a set of concepts and associations among the concepts) that defines a more complex and frequently encountered concept." Unfortunately, schema is not defined consistently from one researcher to another, and many researchers apparently use the term in a manner not that different from Bartlett's original and vague description. However, a wide variety of more specific definitions of our organized knowledge has been presented.

As suggested, a schema is generally used to refer to our knowledge structure for a fairly complex and general concept. Descriptions of possible substructures have also been offered. One frequently used concept is that of a *script.* Schank and Abelson (1977) have used a "script theory" to help explain the constructive elaboration of meaningful material. Scripts refer to our stereotyped knowledge for particular situations that most of us have encountered in life. Schank (1976, pp. 180–181) has elaborated on the meaning of a script as follows:

> A generalized episode is called a *script.* A script is a giant causal chain of conceptualizations that have been known to occur in that order many times before. Scripts can be called up from memory by various words in the correct context, by visual inputs, or by expectations generated through inferences. What a script does is to set up expectations about events that are likely to follow in a given situation. These events can be predicted because they have occurred in precisely this fashion before. Scripts are associated, then, with static everyday events such as restaurants, birthday parties, classrooms, bus riding, theater going, and so on.

Until recently, a script was likely to be based on researchers' intuitions regarding those events that might typically occur in a given situation. However, Bower, Black, and Turner (1979) collected descriptions of various events from students. The students were asked to list as many as 20 activities they associated with such events as going to a restaurant, visiting a doctor, or attending a lecture. There was substantial agreement among the students as to each of these scripts.

For example, when describing attending a lecture, most students listed enter room, find seat, sit down, take out notebook, listen to professor, take notes, check time, leave. Less frequently mentioned activities included such things as ask question, daydream, and look at other students. The researchers defined script elements in terms of their probability of being mentioned. The considerable agreement among the students in describing these episodes indicates that most of us possess stereotyped knowledge for these kinds of events. It is assumed that scripts will be invoked when attempting to comprehend a prose passage. For example, reading a story about a man going to a restaurant will likely lead us to rely on our script for activities in a restaurant in order to understand the story. It is possible that we will elaborate on the story in terms of our script for what "must have happened." Later in this chapter we will show how scripts may be a source of memory errors.

Script theory is a particular elaboration of a frame theory proposed by Minsky (1975; see also Bower, Black, & Turner, 1979). A *frame* is similar to a script except that it applies to our knowledge for a wider range of concepts, including stereotyping about people and knowledge about particular types of literature, games, architecture, or social situations. For instance, when we hear someone mention that she attended a cocktail party at a friend's split-level house in the suburbs, we presumably refer to our knowledge frames regarding cocktail parties, suburbs, and split-level houses and possibly to related frames such as living room, host, or hostess.

Schemata and the more specific scripts and frames are important explanatory devices to help us understand the effect of prior knowledge on memory for prose material. Numerous other concepts have been introduced, including themes, macrostructures, episodes, and grammars. As we mentioned, not everyone uses those terms consistently and there are considerable problems with providing operational definitions. An important step in clarifying the use of these terms is the collection by Bower, Black, and Turner (1979) of script norms. Now it is possible to use this term more precisely so that when a "restaurant script" is discussed, the meaning can be given in terms of the norms obtained. For the present we will avoid the many and subtle complexities found in the use of these concepts and refer, as Bartlett did, to our organized knowledge in terms of schemata, realizing that this concept is not clearly defined.

PRIOR KNOWLEDGE

It is not difficult to demonstrate that understanding (comprehension) of a verbal message, as well as our ability to remember it, can depend on our prior knowledge about the topic of the message. Both comprehension and remembering, in other words, are affected by our schemata for the contents of a passage.

Effect on comprehension

Measures of understanding or comprehension are generally nothing more than subjects' ratings of how well they understood something. Read the following passage.

> The procedure is actually quite simple. First you arrange items into different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities that is the next step, otherwise, you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. At first the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then one never can tell. After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is part of life [Bransford & Johnson, 1972, p. 722].*

Using a seven-point scale where one equals difficult to understand and seven equals very easy to understand, how would you rate your understanding of the passage? Presumably, your rating would not be very high. Although all the words are familiar and any particular sentence is understandable, the passage as a whole does not seem to make much sense. Would it surprise you to learn that Bransford and Johnson (1972) presented this passage to college students and found they rated it fairly *easy* to comprehend? This is true, but these researchers also gave the students some additional information *before* they read the passage. Subjects were told that the passage describes washing clothes. Take another look at the passage with this information in mind. Subjects not given the information behaved as you likely did and rated the passage as difficult to understand. Further, when recall of the passage was tested, the students told what the passage was about before they read it remembered almost twice as much as students who read the passage without knowing the topic. Bransford and Johnson (1972) also found that giving the students the topic *after* they read the passage did not help comprehension or recall. These students rated their understanding of the passage no better than students given no information and both the no-information group and the information-after group recalled about

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*From "Contextual Prerequisites for Understanding: Some Investigations of Comprehension and Recall," by J. D. Bransford and M. K. Johnson. In *Journal of Verbal Learning and Verbal Behavior,* 1972, *11,* 717–726. Copyright 1972 by Academic Press, Inc. Reprinted by permission.

the same amount. Apparently, a critical condition for understanding is the activation of appropriate prior knowledge patterns (schemata) at the time information is being processed.

The effect of prior knowledge on recall

Purpose

To show how prior knowledge of the semantic context of a verbal passage can influence memory for that passage.

Materials

All subjects in this experiment listen to *either* of the following passages.

> The procedure is actually quite simple. / First arrange things into different bundles depending on make-up. / Don't do too much at once. / In the short run this may not seem important, / however, complications easily arise. / A mistake can be costly. / Next, find facilities. / Some people must go elsewhere for them. / Manipulation of appropriate mechanisms should be self-explanatory. / Remember to include all other necessary supplies. / Initially the routine will overwhelm you, / but soon it will become just another facet of life. / Finally, rearrange everything into original groups. / Return these to their usual places. / Eventually they will be used again. / Then the whole cycle will have to be repeated. /
>
> Generally the atmosphere is not conducive to street clothing. / Proper attire lessens this worry. / It may also facilitate dexterity. / Awe-filled spectators surely provide extra motivation. / Hopefully they don't cause distractions. / Finesse and enthusiasm add a lot to the performance, / however, final results constitute the true measure of achievement. / Experiment with ways of throwing. / Making the thick pellets into thin skins is the aim. / You usually cannot select all the constituents. / Consumers choose much themselves. / Your task is to integrate the raw material. / Careful engineering of embellishment placement guarantees consistency of quality. / Once heated no changes can be made. / Consumption is imminent. / Quantity ultimately secures survival. /

Before hearing the passage, subjects are given one of two kinds of instructions. The different instructions define the experimental conditions. Written instructions can be used if the experiment is conducted in a large group and both conditions are tested simultaneously. Should subjects be seen individually or the two conditions tested in separate groups, instructions can be read aloud by the experimenter. Both passages can be used should the experimenter want to increase the generality of the results. The slashes that appear in the stories are for purposes of scoring recall and indicate where pauses should be made when reading the passage. All subjects need a pen or pencil and a blank sheet of paper to write down what they remember of the passage.

Instructions to Subjects

CONTEXT GROUP

In this experiment you will be asked to listen to a short passage that describes washing clothes [running a pizza parlor]. Please try to remember it as best you can. Later you will be asked to write down as much as you can remember from this passage.

NO-CONTEXT GROUP

In this experiment you will be asked to listen to a short passage. Please try to remember it as best you can. Later you will be asked to write down as much as you can remember from this passage.

Procedure

As the first passage says, the procedure is quite simple. Subjects are randomly assigned to either the no-context or the context condition. If subjects are tested in a large group, assignment to conditions can be accomplished by randomly distributing the two sets of written instructions. After subjects receive their instructions, the experimenter can present the passage. The passage should be read slowly with appropriate pauses at the end of clauses and between sentences (that is, where slashes appear in the passage). Immediately after hearing the passage, all subjects are asked to write down as much as they can remember from it. Five minutes is permitted for this recall test.

Summary and Analysis

Memory of the passage can be scored in either or both of two ways. Amount subjects in the two groups recall can be determined by finding the number of words or by recording the number of "idea units" each subject recalled. There are 106 words in each passage, with some words repeated (for example, *be* and *is*). In scoring number of words recalled, a word is considered correct if it appeared in the passage, and it can be scored correct as many times as there are repetitions of that word (for example, subjects can get credit for four *be*'s in the washing clothes passage). The slashes in the passages identify 16 "idea units." When recall is scored according to the number of idea units subjects remember, less attention is paid to the exact wording or to the number of words recalled. A good way to score for idea units is to have two people score each answer sheet and to see whether the two scorers agree. The percentage of times the two scorers agree should be reported.

A test of statistical significance of the difference in mean recall between the two groups can be carried out using a *t* test for independent groups. Statistical comparison can be made for either or both of the two measures of recall (words or ideas).

Recommended Minimum Number of Subjects

Total of 24; 12 in each of two conditions.

Based on an experiment by Bransford and Johnson (1972). The passages used in this experiment are from a dissertation by S. E. Nyberg, State University of New York at Stony Brook, 1975, entitled "Comprehension and Long-Term Retention of Prose Passages."

Effect on remembering

Other experiments have replicated these findings (Bransford & Johnson, 1973; Dooling & Lachman, 1971) and have added other important information about how schemata affect recall. First, it is clear that the effect of prior knowledge on retention is greater than mere repetition of the to-be-remembered material (Bransford & Johnson, 1972; Johnson, Doll, Bransford, & Lapinski, 1974). Bransford and Johnson (1972) found that students who read an "incomprehensible" passage twice still recalled less than half that recalled by students reading the passage only once but given the topic of the passage prior to reading it. This suggests that retention may at times be facilitated more by an effort spent toward understanding the contents of what must be remembered than spending time repeating the to-be-remembered information. A second consequence of prior knowledge is that it affects what particular information may be remembered (Bransford & Johnson, 1973; Dooling & Lachman, 1971). Bransford and Johnson (1973) had students read an ambiguous passage that could be meaningfully interpreted as either about watching a peace march from the fortieth floor or a space trip to an inhabited planet. Students omitted different details in the passage when recall was tested under the two different assumptions. Specifically, a sentence that mentioned that the atmosphere was such that no special suits had to be worn was more likely to be remembered when the theme was thought to be about space than when students considered it as a description of a peace march.

The aforementioned studies suggest that degree of prior knowledge is responsible for differences in remembering. In other words, just how much prior information one has about an event may affect not only whether one understands it but will determine how much and what details one remembers. The greater and more elaborate one's prior knowledge of a topic, the greater one's retention is likely to be. This was demonstrated by an interesting set of experiments by researchers at the University of Pittsburgh (Chiesi, Spilich, & Voss, 1979; Spilich, Vesonder, Chiesi, & Voss, 1979). Consider the following selection from a verbal passage presented to subjects in their experiment:

> Beck, the left-handed relief pitcher, is warming up in the bull pen. The next hitter for the Cougars is the right-hand hitting Carl Churniak, a .260 hitter who is known to hit well in the clutch. Claresen takes his sign, delivers, and Churniak takes the pitch for a ball. Claresen again is ready and pitches, and Churniak swings and hits a slow bouncing ball toward the shortstop. Haley comes in, fields it, and throws to first, but too late. Churniak is on first with a single. Johnson stayed on second [Spilich et al., 1979, p. 289].

Undoubtedly, most Americans would recognize this as a play-by-play description of their national pastime. However, people without prior knowledge about baseball would likely find this passage nearly as incomprehensible as the washing clothes passage was to those not given a description of its contents. Certainly, people possess different degrees of knowledge about baseball, the rules and actions of the game. The researchers at the University of Pittsburgh chose baseball passages for exactly that reason. They wanted to compare retention of baseball information for people with "low" and "high" baseball knowledge.

There was another and equally important reason for selecting baseball information for these experiments. To say that we possess schemata for an area of knowledge does not in any way help us to understand how these schemata might be organized. Within a particular domain of knowledge, for instance, how might our knowledge be organized and how might that organization affect the acquisition of new knowledge? It seemed to the researchers that baseball offered a knowledge domain that had a well-defined conceptual framework in which knowledge would be organized. A major goal of the research was to see if retention was related to such a framework.

The conceptual framework the researchers hypothesized to describe baseball knowledge is shown in Table 14-1. Knowledge of the game is assumed to consist first of *setting information*. This includes *general* information about who is playing, the inning, and so forth, as well as *specific* information about the records of the team and players and *enabling* information, which is information necessary to carry on the game, such as the pitcher is ready to pitch. Baseball also has a definite *goal structure*. The goal of baseball is to win the game. However, there are several subgoals (or *levels*), including scoring runs, getting runners on base, and "balls and strikes." The goal structure is identified in Table 14-1 as hierarchically organized in terms of these four levels. As you can see, this particular conceptual framework also includes a description of *values* that variables associated with the goal structure may take as well as

TABLE 14-1. Baseball Knowledge Structure

Setting

General:	Teams playing, team at bat, team in field, inning, miscellaneous conditions
Specific:	Relevant: teams' records as related to goal structure, players' records as related to goal structure Irrelevant: team attributes, player attributes
Enabling:	Batter at bat and pitcher ready to pitch

Goal structure

Team at bat	*Level*	*Variables*	*Values*	*Team in field*
Winning game	1	Game outcome	Win-lose	Winning game
Scoring runs	2	Score	Domain of game scores	Preventing runs from scoring
Getting runners on base and advancing runners	3	Pattern of base runners	Eight possible patterns	Preventing runners from getting on base or advancing by making outs
		Outs	0, 1, 2, 3	
Having "Balls,"	4	"Balls"	0, 1, 2, 3, 4	Getting "Strikes,"
Avoiding "Strikes"		"Strikes"	0, 1, 2, 3	Avoiding "Balls"

Nongame actions

Relevant nongame actions
Irrelevant nongame actions

From "Text Processing of Domain-Related Information for Individuals with High and Low Domain Knowledge," by G. J. Spilich, G. T. Vesonder, H. L. Chiesi, and J. F. Voss. In *Journal of Verbal Learning and Verbal Behavior,* 1979, *18,* 275–290. Copyright 1979 by Academic Press, Inc. Reprinted by permission.

information in the goal structure related to the opposing team. Finally, as anyone who has seen a baseball game knows, there is also a lot of *nongame action* that has no direct effect on the outcome but must be considered in a complete description of baseball knowledge. The researchers distinguished between *relevant* nongame actions (for example, the catcher returns the ball to the pitcher) and *irrelevant* nongame actions (for example, the crowd yells).

Subjects in the baseball experiments were selected for their prior knowledge about the game. Specifically, a large number of students were given a 40-question baseball test. The test consisted of questions to evaluate a person's knowledge of the game, including terminology and principles of the game but not necessarily trivia information. On the basis of the pretest, high- and low-knowledge groups were defined. Despite the best efforts of the researchers at advertising the experiments, the high-knowledge group was nearly always all male and the low-knowledge group almost always completely female. The major question the researchers asked was how the degree of domain-related knowledge was related to retention of aspects of the game. In one experiment (Spilich et al., 1979) subjects listened to a half inning account of a fictitious baseball game (we presented a selection from that account earlier). The presentation lasted about 5 minutes and was presented auditorily. Afterwards subjects were asked to recall as much as they could and to answer 40 specific completion questions.

Retention of the baseball information was analyzed in terms of the theoretical framework described in Table 14-1. An analysis of subjects' recall suggested that the differential performance of high- and low-knowledge subjects could be explained by differences in knowledge of the relation between game actions and the goal structure and in differences in processing of sequences of game activities. In general the researchers found that high-knowledge subjects remembered more of the game description than low-knowledge subjects and that the quality of recall was different for the two groups. For example, the high-knowledge subjects were more likely to remember actions that produced changes in the more important aspects of the game—such as scoring and activity of runners. Interestingly, the two groups did not differ on information remembered about the highest goal structures: who won and what the score was.

That there is a relationship between degree of prior knowledge and retention should give students an appreciation for course prerequisites. The knowledge provided in many lower level courses is important in aiding comprehension and memory for more advanced topics. Presumably, someone required to take a course in introductory baseball would be able to comprehend and remember a play-by-play description better than someone without this course. The analysis of cognitive structures associated with domain-related knowledge, as exemplified by the baseball experiments, provides valuable insights into the organization of memory schemata. This analysis has important consequences for the construction of instructional prose. Types of knowledge that produce the greatest effect on understanding and retention can be identified and selected for particular emphasis. The results of these experiments also teach us that in planning instructional material it is important to take into account the level of the learner's prior knowledge. Material that is too advanced for the beginning student will have all the impact of a baseball play-by-play on the person with little or no knowledge of baseball.

MEMORY CONSTRUCTION

Comprehension is an active process. The interaction between the learner's knowledge and to-be-remembered prose will often lead the learner to construct meanings that add to the material presented. This is illustrated by experiments showing that people tend to confuse inferences constructed from to-be-remembered information with the originally perceived information. Consider an experiment performed by Bransford, Barclay, and Franks (1972). They asked students at the State University of New York at Stony Brook to listen to ten brief verbal passages. The passages described relationships between a series of items. One passage was "There is a tree with a box beside it, and a chair is on top of the box. The box is to the right of the tree. The tree is green and extremely tall" (p. 201). Following study of the passages, the students were given a recognition memory test for sentences from them. There were actually four types of recognition sentences. One type consisted of sentences actually heard during the study part of the experiment. Other sentences were permissible inferences (for example, "The chair is to the right of the tree"). A third type of sentence changed the spatial relationship described in the original passage (for example, "The box is to the left of the tree"). The fourth type of sentence changed both the spatial relationship and the subject noun of the sentence (for example, "The chair is to the left of the tree").

As you might expect, students most frequently recognized the original sentences as being those actually heard previously. However, the most frequent kind of error subjects made was to select a sentence that was a permissible inference from what was originally presented. The other two types of false sentences were seldom chosen as being part of the original passage. These results provide evidence that subjects use information in the passage to construct a meaningful description of the situation. Later it is difficult to remember whether information was actually presented or whether we constructed it on the basis of the information presented.

Memory errors based on inferences apparently constructed during comprehension of meaningful passages have been identified in many situations (Cofer, 1973; Johnson, Bransford, & Solomon, 1973; Sulin & Dooling, 1974). For example, Johnson, Bransford, and Solomon (1973) provided evidence for constructive processes in memory when subjects processed a series of simple stories. Subjects in the experiments were asked to listen carefully to the stories and be ready for a later retention test. The stories either allowed for inferences to be made ("When the man entered the kitchen, he slipped on a wet spot and dropped the delicate glass pitcher on the floor. The pitcher was very expensive, and everyone watched the event with horror.") or they did not encourage inferences ("When the man entered the kitchen, he slipped on a wet spot and just missed the delicate glass pitcher on the floor. The pitcher was very expensive, and everyone watched the event with horror.") (p. 204).

A recognition memory test followed, and as in other experiments of this type, the nature of the recognition alternatives was varied. One type of recognition sentence was, of course, exactly the same as contained in the original story. A second type of sentence used information from the original sentences but conveyed it in a manner that was inconsistent with the original story. The third type of sentence contained information reasonably inferred from the information in the original story ("When the man entered the kitchen, he slipped on a wet spot and broke the delicate glass pitcher when it fell on the floor."). Students who listened to stories that encouraged inferences were more likely to say that an inference was an original sentence than were students who listened to stories that did not encourage inferences.

Bower, Black, and Turner (1979) demonstrated that people will falsely recall and recognize actions that are based on the underlying scripts in a prose passage but are not actually stated in the passage. This effect increased as more passages that utilized the same script were read. Scripts, you will recall, are descriptions of our stereotyped knowledge for various commonly encountered events. Subjects in this experiment read many different stories that the experimenters assumed would elicit specific underlying scripts. When recall was tested, subjects were likely to recall unstated script actions, and, when recognition memory was tested, subjects were frequently found to falsely recognize an unstated script action.

The previous experiments provide substantial support for the constructive nature of memory, and this hypothesis, originally derived from the work of Bartlett, has gained wide support among psychologists (see Spiro, 1977, 1980). Bartlett's second hypothesis, that memory is largely reconstructive, has been more difficult to substantiate, as research reviewed in the next section suggests.

RECONSTRUCTIVE RECALL

In the previous section we saw that inferences or assumptions made when processing a verbal passage can become part of our memory for the passage. What is remembered, in other words, is partly our own construction. We assume that constructive processes are guided by schemata relevant to the topic or contents of the to-be-remembered passage. Yet schemata may have another role in remembering. Bartlett (1932) argued that recall was largely a reconstructive process. At the time of recall we are likely to remember some general impressions or perhaps the theme of the original prose passage as well as a few outstanding details. On this basis, Bartlett suggested that a memory is reconstructed. The original passage is recalled as "it must have been." In this view recall is not likely to be verbatim but will include paraphrases, inferences, and other distortions of the original passage that are consistent with the subjects' schemata. This is, of course, what Bartlett apparently found when his English subjects wrestled to reproduce the unfamiliar story of "The War of the Ghosts."

Recall was most often inaccurate in a literal sense, and an analysis of the kinds of recall errors subjects made appeared to provide evidence for reconstructive processes.

Problems with a reconstruction hypothesis

Subsequent research, however, has not been particularly supportive of Bartlett's reconstruction hypothesis. For example, many researchers have failed to observe the same degree of inaccuracy and distortion in recall as Bartlett saw (see Spiro, 1977). Further, when alterations or distortions are found, it is often difficult to determine their locus. Although a constructive hypothesis maintains that certain elements are incorporated into memory at the time of study, a reconstructive hypothesis holds that inaccuracies arise from processes operating at the time of recall. As an example of the problem in separating constructive and reconstructive processes, consider the reproduction of "The War of the Ghosts" one of Bartlett's subjects attempted. The subject recalled that one of the men in the story did not go with the others because his relations would be anxious if he did not return home. The original story does not mention that his relatives would be anxious. In the original story we hear the man say that he might be killed and his relatives do not know where he has gone. It is reasonable to infer that relatives would be anxious if the man did not return home. The subject could have made this inference when he read the passage. However, the distortion in the original passage may have occurred at the time of recall. It is possible that the subject had only a vague recollection that the man did not make the trip because his relatives did not know his whereabouts. The subject could be led to reconstruct the original story as it reasonably might have appeared—namely, that the relatives would be anxious if he did not return home. There is no way to decide on the basis of the subject's attempted reproduction whether the change was the result of processes occurring at time of study or at time of recall. However, the abundance of evidence for constructive processes in memory has led many researchers to suggest that such changes are more reasonably explained by processes at the time of study than at the time of recall.

Another problem with a reconstructive view of memory is that research has shown that whether or not evidence is obtained for reconstruction depends on how recall is requested. Hasher and Griffin (1978) asked subjects to read one of the two passages shown in Table 14-2. Each passage is an ambiguous description of either of two events. Passage A describes a man in the woods on a hunting trip or escaping from prison. Passage B describes a long voyage, either that of Columbus or an early manned space flight. All the subjects read one passage with one of the titles presented with the story.

TABLE 14-2. Ambiguous Stories Hasher and Griffin (1978) Used to Investigate Theme-Related Recall

Titles	*Initial paragraph*
	Passage A
Going Hunting An Escaped Convict	The man walked carefully through the forest. Several times he looked over his shoulder and scrutinized the woods behind him. He trod carefully, trying to avoid snapping the twigs and small branches that lay in his path, for he did not want to create excess noise. The gay chirping of the birds in the trees almost annoyed him, their loud calls serving to distract him. He did not want to confuse those sounds with the type he was listening for.
	Passage B
Columbus Discovers a New World First Trip to the Moon	The voyage was long and the crew was full of anticipation. No one really knew what lay beyond the new land that they were heading for. There were, of course, speculations concerning the nature of the new place, but this small group of men would be the only ones who would know the real truth. These men were participating in an event that would change the shape of history.

From "Reconstructive and Reproductive Processes in Memory," by L. Hasher and M. Griffin. In *Journal of Experimental Psychology: Human Learning and Memory,* 1978, *4,* 318–330. Copyright 1978 by the American Psychological Association. Reprinted by permission.

The experimental manipulation occurred after the subjects read the passage. In the presence of some of the subjects, the experimenter appeared to look over her records and notice that a mistake had been made, that the "wrong" title had been assigned to the passage. The subjects were told of the "mistake" and then given the "correct" (alternative) title. The purpose of this ruse was to convince the subjects that they should not rely on the original theme to help generate recall. Other subjects did not have the theme changed and therefore were presented the same theme at study and at test.

The researchers hypothesized that recall under the same-theme condition would lead to reconstructive errors in retention because subjects would reasonably rely on the theme to help them remember the passage. However, when the theme was changed, apparently through a mistake on the part of the experimenter, subjects should discard the theme when generating recall. Therefore the changed-theme subjects would make fewer reconstructive errors. In fact the researchers suggested that the changed-theme subjects would recall more of the actual material in the passage than the same-theme subjects. In other words the different theme subjects, realizing a "mistake" was made, would edit their recall carefully and also work harder to retrieve more details of the original passage because they could not use the original theme to generate recall. Both of the researchers' hypotheses were supported. Subjects in the changed-theme condition made fewer theme-related errors and recalled more of the original passage than did subjects receiving the same theme at study and test. The results indicate that subjects are capable of accurate recall of even complex events such as prose material but that whether recall is largely reconstructive or literally reproductive will depend on the demands made of the subjects when retention is tested.

The accommodative reconstruction hypothesis

Not all researchers are ready to consider reconstructive errors in retention as due merely to careless editing or overreliance on theme-related knowledge. Spiro (1977, 1980) has argued that if the conditions are right, memory will "change" to accommodate new information added after the original experience. Evidence for an "accommodative reconstruction" hypothesis comes from an interesting experiment that appears to escape the criticisms of other studies that have attempted to show reconstructive processes in memory. Subjects in Spiro's experiment were presented stories designed to tap their knowledge about how human relationships are affected by various kinds of events. The basic story described an engaged couple, Bob and Margie, and the fact that Bob did not want to have children. Two different versions of the story were constructed to provide subjects with a positive or negative expectation about the future of Bob and Margie's relationship. In one version Bob finds out that Margie also does not want children (positive expectation), and in the other version Bob finds out that she does (negative expectation).

Subjects read one of the two versions of the story. Then the experimenter casually informed the subjects that (1) Bob and Margie did get married and are living together happily or (2) Bob and Margie eventually broke off the engagement and have not seen each other since. The subsequent information about Bob and Margie is either consistent or inconsistent with expectations based on the previous story, depending on which version the subjects were presented. For example, knowing that Bob and Margie disagreed about the important issue of having children, one would not find it unreasonable for them to break off their engagement. On the other hand, that version of the story is not entirely consistent with the message that they got married. Similarly, knowing that Bob and Margie agreed about the child issue, one could reasonably expect them to get married. Less consistent with that version of the original story is the message that they broke off the engagement. According to Spiro (1980), if the accommodative reconstruction hypothesis is correct, then three types of information will be "blended" over time: details remembered from the original story, the subsequent message about Bob and Margie's present condition, and the subjects' general knowledge about interpersonal relations, courtship, and marriage. When the story and the subsequent message were "contradictory," it was hypothesized that accommodative processes would operate to increase coherence of the information presented. Specifically, recall errors in the contradictory conditions were expected to show reconciliation of the conflicting information. For example, the disagreement about children may be remembered as less severe than it really was when subjects later learned that Bob and Margie got married.

The results tended to support the accommodative reconstruction hypothesis. Accommodative errors occurred almost exclusively in the contradictory condition and the errors were in the direction of reconciliation of the conflicting information. This occurred even though subjects were told explicitly to recall as best they could and avoid giving personal reactions or feelings about the story. Accommodative errors also increased with time, with more errors observed after a three-week retention interval than after a two-day interval. Examples of recall errors that attempted to reconcile the original information are "They separated but realized after discussing the matter that their love mattered more" and "She was only a little upset at the disagreement" (Spiro, 1980, p. 91). Spiro (1980) obtained these results only when subjects believed that the purpose of the experiment was to investigate people's reactions to interpersonal relationships and not in the context of a standard memory experiment. Spiro argued that conventional laboratory studies of memory will not tend to reveal accommodative reconstruction because subjects usually isolate material learned in a memory experiment from their own general knowledge. Only when an experimental situation was created such that subjects were encouraged to use their general knowledge of the situation was evidence for accommodative reconstruction obtained. Further, the recall errors of subjects receiving conflicting information were not apparently fabrications or guesses based on theme-related information. When subjects in the conflicting conditions were asked to indicate their confidence that the remembered statements were actually part of the original story, statements indicative of accommodative errors were accorded at least as much confidence as were statements actually from the passage. In other words, the subjects were apparently confident that they were remembering the passage as originally presented. Under certain conditions a memory can be "changed" in order to accommodate new information. Before examining some of the possible implications of this view of memory, we will look at another situation and series of experiments that have also led researchers to conclude that memory can be changed as a consequence of new information.

Reconstruction in eyewitness reporting

It's usually over very quickly. Our attention is often drawn to it by a loud noise or unusual sight or sound. Later someone is apt to ask us what happened. We are talking about an event to which we are an "eyewitness." It may be a car accident, an apparent crime, or simply an everyday event we happened to observe. Our ability to remember details of the event may be critical in determining who was present and under what conditions the event occurred. Many times eyewitness reports have significant consequences for someone, as when a person is placed at the scene of a crime or the responsibility for a traffic accident is assigned. But just how good is our memory in these situations? In other words, what kind of eyewitness are we likely to be?

An interesting series of experiments performed by Loftus and her associates at the University of Washington has provided important and often surprising answers to these questions (Loftus, 1975, 1977, 1979b, 1979c; Loftus, Miller, & Burns, 1978; Loftus & Palmer, 1974). Her results also have provided evidence for reconstructive processes in remembering. The general methodology of the Loftus experiments is as follows. Subjects view an event such as a film of a car accident. They are then asked specific questions about what happened. An experimental variable is introduced at the time the subjects are questioned—that is, after they have viewed the event. Loftus has been chiefly interested in how information introduced after an event affects what people say they remember of the event. Consider the following experiment.

Loftus and Palmer (1974) showed that the wording of a question can influence what observers report about an event they have witnessed. In one experiment college students viewed a series of films, each depicting a traffic accident. After each film the students were asked to provide an account of what had happened and to answer specific questions in the form of a questionnaire provided by the experimenter. One of the questions was of particular interest. It asked about the speed the cars were traveling when the accident occurred. The general form of the question asked of all students was "How fast were the cars going when they __________ each other?" For different groups of students the missing word was one of the following: *smashed, collided, bumped, hit,* or *contacted.* The investigators found that the students' estimates of speed depended on the verb used in the question. The average speed reported by students reading *smashed* was 40.8 mph. Students seeing the exact same events but reading *contacted* reported that the cars were going 31.8 mph. Clearly, these results have important implications for the way an eyewitness is questioned. The results also suggest that our memory may be changed by information added after an event. Loftus and Palmer (1974) concluded that varying the nature of the verb in the question caused the subjects to remember the event as being more (or less) severe than it really was. In other words, they suggested that people's memory for an event was altered in accord with the information supplied by the verb in the sentence.

If memory is actually altered as a consequence of the phrasing of the question, then subjects might be expected to "remember" other things that are in line with this "new" memory. A second experiment by Loftus and Palmer

(1974) tested this possibility. They asked students to view a film of a multiple-car accident. The accident lasted about 4 seconds. As in the previous study, the students were asked to describe in their own words what happened and then to answer specific questions provided by the experimenter. Two groups of students were asked about speed of the cars. One group was asked using the verb *smashed;* the other group was asked using the verb *hit.* A third group of students did not receive a question about speed. All the students were dismissed and asked to return 1 week later. The critical question was presented on a second questionnaire given to the subjects when they returned. The question was "Did you see any broken glass?" There was actually no broken glass in the accident. As in the previous experiment, subjects gave different estimates of speed depending on the verb used: *smashed,* 10.46 mph; *hit,* 8.00 mph. The probability of saying yes to the question about broken glass also varied with the verb used. Of the subjects asked one week earlier about speed using the verb *smashed,* 32% said they saw glass. Only 14% of the subjects asked using the verb *hit* said they saw glass, and 12% of the subjects not receiving any question about speed answered the glass question positively. The investigators concluded that information added after the event—for example, the fact that the accident was one in which cars "smashed" together—produced a shift in the subject's memory in the direction of being more similar to the event the verb suggested. When cars smash together, broken glass can be expected. The students apparently remembered it that way.

In another set of experiments, Loftus (1975) showed that questions containing false presuppositions about an event can also influence what subjects say they remember. After viewing a traffic accident, subjects were asked "How fast was the white sports car going when it passed the barn while traveling along the country road?" There was in fact no barn in the film. One week later subjects who were asked this misleading question were more likely to say they remembered a barn than subjects who were not asked a question with the false presupposition. Another experiment demonstrated that even a direct question such as "Did you see a barn?" had an effect on what people said they remembered a week later. People who had been merely asked about whether an object was present were more likely to say they remembered that object than those not asked about the object.

According to Loftus, information added after the event literally changes the original memory. What is remembered is reconstructed on the basis of details that are remembered and information that has been since integrated with the original memory. Yet there is an alternative explanation for what we have seen so far, as perhaps you have detected. How do we know that subjects in these experiments are not simply conforming to the demands of the experimental situation? Suppose the subject, when asked about a barn in the film containing no barn, does not actually remember seeing a barn but does remember that the experimenter asked about one? This subject may respond that a barn was present even though he or she does not actually remember one. In a more recent series of experiments Loftus and her associates presented more convincing evidence that memory is actually altered, and they also designed an experiment to answer critics who say that subjects are merely conforming to the experimental situation.

Loftus, Miller, and Burns (1978) also asked subjects to witness a car accident and they also presented misleading information in the form of a question. In this experiment the events to be witnessed were on a sequence of 30 slides, which included pictures of a red Datsun hitting a pedestrian after turning at an intersection. Half the subjects in this experiment saw the car stopped at a stop sign before hitting the pedestrian. The other half saw the car stopped at a yield sign. After they viewed the slides, the subjects were given a series of questions. For half the subjects one of the questions was the following: "Did another car pass the red Datsun while it was stopped at the stop sign?" The other half received a similar question but it mentioned a yield sign. Remember that half the students actually saw a yield sign and half saw a stop sign. The critical question was presented so that half the subjects received consistent information (they saw a yield sign and the question mentioned a yield sign) and half the subjects got inconsistent information (subjects saw a yield sign and the question mentioned a stop sign).

Twenty minutes later the subjects were given a forced-choice recognition memory test. The test consisted of pairs of slides. Each pair contained one slide the subjects actually saw and another slide closely resembling the original scene. The critical pair showed a red Datsun stopped at the intersection at a stop sign and a red Datsun stopped at a yield sign. When the earlier question had presented consistent information (stop sign seen and stop sign mentioned), the subjects chose the correct slide 75% of the time when viewing the critical recognition pair. When the earlier question gave misleading information, only 41% of the students selected the correct slide. Given that the students were asked to select the scene that they actually remembered seeing, this result is rather convincing evidence that some of the subjects remembered the scene in accord with the information that was added after they viewed the original scene.

It is still possible, though, that subjects are conforming to the experimental situation and responding in a way that is cued by the experimental procedure. That is, subjects asked a question mentioning a stop sign may select a slide showing a stop sign, particularly if they are not really sure what the original sign was. To eliminate this alternative explanation for their results, the researchers carried out another experiment that was similar to the first but that gave subjects the chance to detect the experimental manipulation. After answering the questionnaire and receiving either consistent or misleading information, all subjects were told that some people had received a questionnaire that contained a question designed to make people believe they saw a different sign than had been presented. Subjects were invited to indicate whether the questionnaire they had received had the misleading item. Subjects, in other words, were asked to determine whether the questionnaire they had been given contained misleading or consistent information. The researchers reported that only 12% of the subjects receiving misleading information decided that they had indeed been given misleading information. Almost 90% of the subjects receiving misleading information felt that the information given them was consistent with what they remembered. These results, together with the results from the recognition memory experiment, provide convincing evidence that memory is altered by the addition of new information. This idea is consistent with the accommodative reconstruction hypothesis offered by Spiro (1980), which was discussed previously and, as we will see in the next section, challenges some popular views about the permanence of information stored in memory.

IS MEMORY PERMANENT?

None of us would deny the fact of forgetting. Information once learned can often, at a later time, not be recalled. However, we have seen on more than one occasion in this text (especially in Chapters 6 and 10) that forgetting need not mean that an event is no longer stored in memory. It is possible that a presently unrecallable event will, on a later test, when perhaps different retrieval cues are present, be recallable. Is it possible that *all* information we have learned is stored in the brain, that memory is actually permanent?

Two psychologists at the University of Washington recently conducted an informal survey of 169 people from all over the United States to determine what they thought about this issue. Loftus and Loftus (1980, p. 410) asked individuals with formal training in psychology and people without any psychology background (including lawyers and taxicab drivers) to say which of the following two statements best represented their views about human memory.

1. Everything we learn is permanently stored in the mind, although sometimes particular details are not accessible. With hypnosis, or other special techniques, these inaccessible details could eventually be recovered.
2. Some details that we learn may be permanently lost from memory. Such details would never be able to be recovered by hypnosis, or any other special technique, because these details are simply no longer there.

Loftus and Loftus (1980, p. 410) found that 84% of the 75 psychologists questioned agreed with the first statement; 14% agreed with the second statement;

and 2% gave some other answer. Sixty-nine percent of the nonpsychologists agreed with the first statement; 23% agreed with the second statement; and 8% were noncommittal. A sizable majority of both psychologists and nonpsychologists believed that memory is permanent.

What were the reasons for their choice? Most people opting for a permanent memory hypothesis mentioned the fact that they had experiences in which something had apparently been forgotten but was recovered spontaneously or was triggered by the right set of circumstances. Many persons with psychology training also mentioned the work of the neurosurgeon Wilder Penfield (see Penfield & Roberts, 1959). Penfield has published accounts of individuals who appeared to remember events long forgotten when brain stimulation was applied to parts of the temporal lobe. Penfield operated on epileptic patients whose conditions were serious enough that damaged areas of the brain had to be surgically excised to lessen the severity of their illness. In order to localize the damaged area, Penfield probed the surface of the cortex with a mild electric current prior to making an excision. Patients were conscious and capable of conversation with the surgeon during the operation. Penfield found that when certain areas of the temporal lobe were stimulated, the patients reported what appeared to be memories of past events. Penfield's procedure and results are widely cited in the psychology literature and often discussed in introductory psychology textbooks. One interpretation is that the brain acts like a "videorecorder" to store permanently all that is experienced. Only the right "switch" needs to be found to reveal what is stored in memory.

The respondents to the questionnaire also mentioned other reasons for believing in a permanent memory, including the apparent recovery of memory through hypnosis or psychoanalysis. Yet Loftus and Loftus (1980) are quite skeptical about the evidence for a permanent memory, including that presented by Penfield. They pointed out that Penfield himself admitted to obtaining evidence of "memory recovery" in only 40 out of the 1132 patients who were tested. Further, when these 40 cases are examined closely, Loftus and Loftus argue that the reported "memories" look more like reconstructions of an event. A similar reaction to these reports was given by Neisser (1967, p. 169) some years ago: "In short, the *content* of these experiences is not surprising in any way. It seems entirely comparable to the content of dreams, which are generally admitted to be synthetic constructions and not literal recalls. Penfield's work tells us nothing new about memory."

Loftus and Loftus (1980) also point out that there is evidence to indicate that under hypnosis people will construct memories merely to please the hypnotist. They describe an experiment (see Putnam, 1979) in which subjects viewed an automobile accident, then were hypnotized and asked to describe what happened in the original situation. The experimenter found that hypnotized individuals were more likely to be influenced by leading questions than people who were not hypnotized. As regards the often spontaneous or prompted recovery of memory that we all have experienced, Loftus and Loftus remind us that because one or even many memories are recovered does not necessarily imply that all memories can be recovered.

Despite the widespread belief in the permanence of memory, Loftus and Loftus find all the evidence lacking. Further, as you have seen in this chapter, there appears to be evidence for the contrary opinion, that memory is *not* permanent and that it is changed as a consequence of adding new information. The question will surely be debated for some years to come.

Summary

The English psychologist, Bartlett (1932), found that recall of prose material was rarely accurate in a literal sense and that successive reproductions of a story assumed a stereotyped form. His results provide evidence for an effect of prior knowledge on remembering and for both constructive and reconstructive processes in memory. Bartlett originally described our knowledge in terms of memory schemata. Contemporary researchers have attempted more precise definitions of the types of knowledge we might have and have introduced concepts such as scripts and frames.

The influence of prior knowledge on comprehension and remembering was nicely revealed in experiments by Bransford and Johnson (1972). They asked subjects to read a series of individually meaningful sentences describing a particular topic, for instance, washing clothes. Subjects who did not know the topic beforehand rated the passage as more difficult to comprehend and remembered significantly less of it than subjects who knew the topic before reading the passage. That degree of prior knowledge is related to performance on a memory test was also shown when retention of baseball information was compared for high- and low-baseball knowledge subjects. Analyses of recall for individuals of differing degrees of knowledge provide important information as to the way information is represented in memory.

Constructive and reconstructive processes are difficult to distinguish experimentally because similar errors in recall are expected on the basis of both these processes. In addition, research has shown that whether evidence for reconstruction or literal reproduction is obtained depends on how retention is tested. Recently, however, evidence has been found for accommodative reconstruction when subjects are presented information that conflicts with their generalized knowledge of the situation. Other evidence that memory might be "changed" by subsequent information comes from an interesting series of experiments conducted by Loftus. She showed that information added after a complex event has been witnessed can cause *serious distortions in subjects' memory for that event. These results seem to contradict the apparently widely held view that memory is permanent.*

In the past 10 to 15 years psychologists have turned increasing attention to our memory for meaningful kinds of events, such as memory for prose material or real-life scenes that are part of eyewitness reports. The results of these studies will have important implications for understanding how such information is represented in memory and may also have important practical consequences, as in the planning of curricula, presentation of prose material for learning and retention, and such critical activities as eyewitness testimony.

Recommendations for further reading

We recommended that all students of memory at some time read the classic work of Ebbinghaus (1885/1964), and we must recommend equally strongly that they read the work of Bartlett (1932). Bartlett's views are the starting point for most modern discussions of our memory for prose material. Contemporary models of cognitive structures, including descriptions of schemata, scripts, and frames, are found in many recently published volumes. An excellent introduction to this important area is *The Structure of Human Memory,* edited by Cofer (1976). Also informative are more advanced discussions found in Shaw and Bransford's (1977) *Perceiving, Acting and Knowing* and in Bobrow and Collins's (1975) *Representation and Understanding: Studies in Cognitive Science.* A frame theory is outlined by Minsky (1975), and a lengthy article by Bower, Black, and Turner (1979) provides an important demonstration of the role of scripts in our memory for meaningful material. Loftus's (1979a) *Eyewitness Testimony* offers a valuable lesson in the application of research on human memory to this very important problem. Finally, a recent article by Loftus and Loftus (1980) is a highly readable description of the controversial question of whether memory is permanent.